Reactive milling (or grinding) is a process that is carried out with the use of popular ball mills (mainly planetary), and its purpose is not only to refine and mill the input material but also to cause its reaction - usually with gas (e.g. hydrogen) filling the working cylinder. This technique, popular in materials engineering, is also sometimes called the "brutal chemistry"method and allows chemical reactions to be carried out under temperature and pressure regime significantly different from the conditions necessary for the reaction to take place in the classic way. Often this method is used to synthesize binary and ternary metal hydrides, as well as complex hydrides which are considered as materials for hydrogen and heat storage. This process, known for many decades, is very easy to apply and brings extremely good results, which is why it is very popular and used in hundreds of laboratories around the world.

In the classically used version, the reaction is usually carried out with cylinders made of a material with high abrasion resistance and grinding media in the form of steel or ceramic spheres for grinding the batch material. The fact that this technology can be used to synthesize materials under non-equilibrium conditions is attributed to the presence of significant stresses and local overheating at the interface of the colliding spheres and the fact that the batch material is "trapped" between them, which is subjected to extreme stress and strain. Unfortunately, defects in the material that are the “side effects” of the process cause that when materials are ground for hydrogen storage, they do not reach their maximum capacity - mostly due to mechanical disordering.

In a most recent experiment [1], the authors of the proposal found that some of the solid-state hydrogen storage materials can react very successfully with hydrogen in the reactive milling process, even if grinding media are not used. Moreover, it turned out that the products formed as a result of such a reaction are characterized by a significantly higher capacity (hydrogen content) precisely due to the lack of the disordering effect of the material. This process was called self-shearing reactive milling and allowed activation (first hydrogen absorption) by the FeTi alloy, which typically requires cyclical heating and cooling in a hydrogen atmosphere to become active.

The aim of the project is to investigate the basic phenomena and mechanisms accompanying the activation of solid-state hydrogen storage materials alloys in the reactive self-milling process and the possibilities of synthesizing the so-called high-temperature hydrogen storage materials alloys in a similar way.

[1] Patel, A. K., Siemiaszko, D., Dworecka-Wójcik, J., & Polański, M. (2022). Just shake or stir. About the simplest solution for the activation and hydrogenation of an FeTi hydrogen storage alloy. International Hournal of Hydrogen Energy(in press, published online December 9th 2021).